



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE ERUPTION OF MOUNT PELÉE, 1851.¹

TRANSLATED FROM THE FRENCH OF LEPRIEUR, PEYRAUD AND
RUFZ BY

T. A. JAGGAR, JR.

TRANSLATOR'S NOTE.

THE following account of the eruption of 1851 is a valuable geographical record for students of the recent volcanic happenings in Martinique, and the only printed copy of the original report known to the writer is in the library at Fort de France. The region described as the seat of activity in 1851, a gorge adjacent to that containing the Etang Sec, is practically identical with the site of the crater of 1902, or parts of it, and the very careful description of earlier conditions there throws light on many of the phenomena of the later eruptions.

The investigating commission of 1851 report (1) abundant *pumice* in the old rocks of the mountain, (2) no activity at the summit lake, (3) unusual amount of water in the Etang Sec, (4) entire absence of lava or incandescent material, (5) fragments of diorite ejected, (6) hot waters, steam and dry rock-dust from the vents, (7) a local tornado, (8) sulphuretted hydrogen, (9) a buzzing noise or intermittent detonations. In a very suggestive footnote they comment on the superficial quality of the explosions, and although not themselves geologists, they conclude that Mount Pelée has never ejected molten lava in any considerable amount, but has always belonged rather to the cinder-cone type of volcanoes. There are, in fact, some ancient lava flows and intrusive sheets, but they are rare, the tuffs and agglomerates everywhere predominating.

No attempt has been made to eliminate errors in the original account. There are some geological and chemical phrases that are

¹ Official Report of 1851.—The manuscript was apparently drafted by Dr. Rufz. The translator obtained access to the printed copy of this report, kept in the library at Fort de France. Eruption du Volcan de la Montagne-Pelée. Pub. in 1851. E. Ruella & Ch. Arnand. Imprimeurs du Gouvernement, Rue du Bord de Mer, 94. République Française.

antiquated and obviously inaccurate. The same is true of the opening sentence — there is certainly good historic evidence of the activity of Pelée before 1851. The notation for magnetic directions is obscure, and in such cases the original symbols are reproduced in the footnote. Making due allowance for trifling inaccuracies, the report as a whole is the most complete and scientific record extant of the topographic details of the southern slope of Pelée prior to the eruptions of 1902-03.

October, 1903.

THE OFFICIAL REPORT, 1851.

A tradition without historical foundation records Mt. Pelée to be a volcano. The conical form, the crater lake, the pumiceous soil, all fostered this supposition. It was known also that in one of the gorges there was sulphur, and the inhabitants living near called this the Soufrière. The druggist Peyraud made a scientific excursion there in 1838¹ and brought back stalactites of pure sulphur attached to the leaves of a tree.

¹ Letter to the "Directeur de l'intérieur," by Peyraud: —
Monsieur le Directeur général.

J'ai l'honneur de vous adresser un petit flacon contenant de l'eau que j'ai rapportée de la source minérale qui se trouve sur les terres de M. Huc, à la naissance de la Rivière Claire. Je dois vous observer que cette eau que l'on m'avait dit être à 60° Reaumur, n'est dans ce moment qu'à 16°, et l'air ambiant à 18°. J'y joins un échantillon de la matière jaune qui tapisse les bords du morne d'où cette eau découle, puis un morceau de bois recouvert d'un mousse qui répand une forte odeur de marée. Ce bois a été recueilli à quelques pieds au-dessus de la source minérale, un peu à gauche en faisant face à la montagne. Je vais m'occuper de l'analyse de cette eau et m'empresserai de vous en faire connaître le résultat.

Pour vous donner une idée de la quantité de gaz hydrogène sulfuré qui se dégage dans les environs de la source, je vous envoie un porte-crayon en argent que je portais sur moi lors de mon excursion. Il est à regretter que la nature ait placé cette eau dans un endroit ne permettant pas d'y former un établissement qui aurait été bien avantageux pour la colonie. Plus tard je ferai en sorte de vous adresser le plan de l'endroit où se trouve la source. Si vous désirez une plus grande quantité d'eau je me ferai un vrai plaisir de vous en faire puiser, que je renfermerai dans les flacons à l'émeri afin d'éviter la perte du gaz.

Je compte aller, dans quelques jours, parcourir la route de la Trinité afin de visiter l'endroit qui répand une odeur sulfureuse et vous rendrai compte immédiatement du résultat de mes recherches.

Je suis avec respect, Monsieur le Directeur général.

Votre très humble serviteur,

Saint Pierre, le 20 Mai, 1838.

P. PEYRAUD.

Recently the inhabitants of the Prêcheur heights have complained of a strong sulphurous odor. Some of them have visited the Soufrière and report a fuming hole which has appeared, the vapors mixing with the clouds and thus being imperceptible to sight at a distance. On the 3rd of August the patrolman Carbone! brought in a partridge found dead near the new opening, and he said there were many others, that all the birds dropped dead when they flew over the fatal cavity. Like the Avernus of the Ancients,

Quam super haud ullæ potevant impune volantes
Tendere eter pennis : Talis sese halitus atris
Faucibus effundeus supera ad convexa ferebat ;
Unde locum Graii dixerunt nomine Avernus.

Virgil.

This year (1851) from the 10th of May, there were no earthquakes in Martinique, but Guadeloupe had many of them and was in continual fear. August 5, St. Pierre was peaceful ; the weather had been fine. Towards 11 p. m. a dull, distant sinister noise began, like thunder ; it was mistaken for thunder, or for the roar of the river in flood. The noise increased, waked many people and caused alarm.

I was in my villa of Fonds Canonville, very near the source of the sounds. I thought it was thunder, but was astonished at its continuance ; I heard the workmen call me from without. They shouted "Do you not hear that noise ?" I answered, "Yes, it is thunder !" "No, it is the Soufrière." I rose and looked towards Mt. Pelée, but could see nothing : the noise continued. The rest of the night was passed in great anxiety, and torches were seen indicating the flight of many people. No one knew anything definite and the answer to all questions was, "C'est la Soufrière qui bout !"

St. Pierre was equally frightened. In the morning roofs, pavements, leaves of trees, all were covered by a thin layer of grayish cinders, which made the town look like a European city covered by the white frost of the early days of autumn.

These ashes covered the country between the city and Mt. Pelée, covered Morne Rouge, and extended to Carbet. The

stream called the Rivière Blanche, because of the color of its water (caused, like the "yellow baths" of Guadeloupe, probably, by the presence of an iron hydrate) became black, charged with ashes or mud, and this coloration of the water could be seen far out to sea, as in time of flood.

The spirit of the city was an anxious curiosity, dissimulating, according to the light-hearted spirit of the country, under many jests. A few brave spirits made a reconnaissance of the mountain, and from their description the first accounts were published in the "Courrier de la Martinique" and in "Les Antilles."

The government appointed an investigating commission; Le Prieur, chief Pharmacist of the colonial hospitals, who had already made several explorations in Guiana: Dr. Rufz, and pharmacist Peyraud. The present document is the report of this commission.

The general aspect of La Montagne Pelée, seen from St. Pierre, is that of a great cone, from whose summit descend sharp spurs down to its base, these spurs being separated by an equal number of gorges or valleys. It resembles the cone formed by a pleated filter paper. In order to reach the summit of the mountain it is necessary to follow one of the spurs, for the valleys are often precipitous gorges. On August 28, we took what is considered the most direct route, by way of the sugar plantation "Rivière Blanche," near the farm Paviot, and came out at the habitation Ruffin. Ruffin is a farm $1\frac{1}{2}$ hours horseback from St. Pierre, 551 meters above the sea. We slept there: 7 a. m. the morning of Aug. 29, the thermometer marked in air 23° Centigrade and 22.5° in the earth. At St. Pierre at this hour, 27° or 28° . We descended by a zigzag path to the bottom of the ravine of the Riviere Claire. This path is cut in "*pumites*," or local pumice stones which are white and friable, in little fragments. The Rivière Claire is so-called by way of contrast to the Rivière Blanche. The latter, whose waters are always milky, comes from one of the creases in the mountain separated from the Rivière Claire by a steep spur: both flow separately above, but unite below, and continue to the sea under the name of the Rivière Blanche. It appears that now the Rivière Claire receives the volcanic mud and blackens the

Rivière Blanche, no longer deserving its name of "clear." At the bottom of the ravine where we were, the Rivière Claire forms a cascade 2 or 3 meters high: it is only a brook that one can easily jump over. Its banks were covered with from 15 to 20 centimeters of mud. The water has ceased to be drinkable.

After having crossed the bed of the Rivière Claire, it became necessary to climb the opposite slope which is a very abrupt escarpment, where the first explorers had to construct a path, by means of a ladder of ropes and lianas: for a half-hour one goes upstairs in this fashion. The slope becomes easier and we are in virgin forest. There is no path. In order to advance in the direction of the hill one must push through palms, and tree-ferns, the long spines of which make treacherous support. This is the forest zone called the "little woods" in the colonies as opposed to the "great woods" where there are great trees remarkable for their height and the size of their trunks. About ten o'clock we reached the point where the first traces of the eruption were visible. The foliage of the ferns, bananas and other plants which form the vegetation of these places was dried and reddened as if it had been burned; on the leaves and on the soil also there was a thin layer of dried mud, the remains of volcanic ejections. Here the barometer registered a height of 846 meters. From there on the volcanic mud became more and more abundant. It covers the leaves in a dry adherent mass, and on the ground it is viscous and sticky and appears like a gray clay, in some places more than a foot thick: little scintillating points may be distinguished on the surface which the lens, and later a chemical analysis, showed to be globules of iron sulphide. As we had noticed that the leaves, branches and trunks of trees were plastered with mud only on the side toward the volcano, we thought at first that the weight of the mud was sufficient to explain the inclination of all these objects; they seemed to be depressed violently, but the quantity of mud on the leaves was only a few millimeters thick and not sufficient to break the branches; we soon saw that something more than the weight of mud must be called in to account for the disorder, and a sort of chaos through which it soon became necessary to thread our way. Here were great trees broken, overturned,

twisted, not only in one direction but in all directions, and often in a direction the reverse of that affected by the weight of the mud. This brought to us the conviction that something like an explosion had taken place. The air, displaced first by hot vapors blown out of the volcano, and rushing into the vacuous places so formed, became involved in a whirl or local tornado : we say local for the signs of disturbance were only in the vicinity of the volcanic opening. The people who fled with torches from the houses lower down the slope did not have their flambeaux blown out by the wind.

Climbing higher, the mud layer became thicker making the walking difficult and woe betide those with light or ill-made shoes ! At the same time the crest of the spur we were following became narrower ; a moment arrived when we had on the east, on the right-hand side, the ravine of the Rivière Claire. It was this last we were following, guided by the vapors that were rising from this gorge. Beside it we walked on a high crest rising above the bottom of the valley 50 to 60 meters ; at our feet the valley of the Rivière Claire was plainly visible. From this point we obtained a full view of the effects of the eruption of the 5th of August, in all its extent and horror. The verdure is absolutely gone from the place which was formerly the scene of densest foliage. Trees, leaves, flowers, all are buried as though under a gray shroud. It is the sadness of winter with the trees denuded and smutted with a black snow. Though we found no dead birds, we also heard none of them singing. The mountain whistler, whose sweet pipe is associated with the melancholy grandeur of our "grands bois," the whistler of our mountains has fled from these his former haunts ; we did not even meet the deadly *trigonocephalus* whose home is here. A dread silence, a sky obscure by vapor, an atmosphere charged with a strong odor of sulphuretted hydrogen, complete this scene worthy of Tartarus. The slope of the bed of the ravine in the midst of all this desolation, is very steep ; it extends from the east toward the west from the summit peak of Mount Pelée called "Morne LaCroix," but the bottom is not continuous ; it is interrupted by several cliffs ; here and there, in the midst of the general grayness rifts may be seen where the soil is rent

bare ; these are crevasses made perhaps by the steam of the mountain or by earthquakes about the rent. Ancient pumices may be seen of various colors, reddish or grayish, and among these are some rare masses of gray dioritic rocks, or of porphyries that the ancient fires have hurled out of the entrails of the earth along with the pumice.

In the upper part of the valley there are rising dense sheaves of whitish smoke which mark two volcanic vents from which came the mud that covers the valley and its environment. At eleven o'clock we arrived at the level of these two craters, from which we were separated only by the valley itself. A barometer reading here gave an elevation of 966 meters above sea-level. The temperature of the air was $23^{\circ}.5$ at twenty-five minutes after eleven o'clock ; after removing the mud, the temperature given by a thermometer buried in the soil was $21^{\circ}.5$; this was $\frac{3}{4}\%$ more than the heat found at the lower station, where the persisting vegetation protected the soil from the direct action of the sun's rays.

But this was not the upper limit of the action of the volcano. It was easy to see that mud had been thrown several hundred meters above the orifices, for the line of green verdure did not begin to appear except at the very summit of the mountain. We wished to reach the summit in order to see better the actual extent of the lands covered by erupted material, but our guides assured us that the ascent here was not possible, that we should be cut off by cliffs and that there was no path. Looking over the scene of desolation, we estimated that the action of the volcanic eruption took place within a perimeter of something more than eight or nine hundred meters.

It was necessary to go down to the bottom of the valley in order to explore and examine the orifices themselves ; to do this we had to slide down, with the aid of roots and lianas, an abrupt cliff 15 or 20 meters high ; the younger and more agile members of the party decided to do this under the leadership of Mr. Peyraud. As they approached the fuming vents ahead of them, they found the mud deeper ; the valley was divided in two branches by a spur from the summit of the mountain. In the right hand branch are the two craters ; they lie in a N-S line, separated by a space of 25 to 30 meters, in the midst of which

the waters which descend from the mountain have worn a channel 12 to 15 meters deep. At this time the vents were almost free from vapor — something hitherto unknown since the day of the eruption. Therefore it was possible to examine them thoroughly. The left hand vent opens in the right slope of the spur which divides the upper part of the valley; it is of irregular, circular form and three or four meters in diameter. From this opening the thick vapors are discharged with the greatest force; these appear brilliantly white in the sunlight, spreading to leeward in a billowy plume, but they are denser and blacker in the immediate vicinity of the orifice; the emission of vapor is not preceded by any subterranean noises. The detonating sounds heard take place at the instant the vapor escapes from the hole, and this leads us to the belief that this noise is the result of the expansion of steam in air, a phenomenon entirely comparable to the detonation of a cannon.

This opening is reached by a sort of open gallery about a meter and a half wide excavated in a reddish pumiceous rock covered with dark gray mud, which was unstable and so hot that it was impossible to hold it in the hands more than a few seconds, especially that on the immediate rim of the crater. Here the attempt was made to sound the depths of the cavern by means of a zinc pail attached to a cord. But when the cord was withdrawn the pail had disappeared without evidence as to whether the loss was due to insecure knots or the melting of solder. The cord was impregnated with a strong smell of sulphuretted hydrogen. Stones dropped into the hole were heard to fall quickly with a noise as of striking a liquid. An alcohol thermometer buried in the soil rose almost to its highest limit. The barometer gave an elevation of 883 meters, indicating that these rents were 83 meters below the summit of the spur, where the rest of us had remained.

This crater had already been visited by Mr. de Maynard but that was in the first days of its formation when steam action was so violent that details could not be seen.

Across the gulch, but separated as we have said by twenty-five or thirty meters, is the other higher orifice, and this is also the greatest vent,—it is harder to reach than the first, lying at

the bottom of a great four-sided funnel behind which is a very high cliff; this funnel opens against the wall of the cliff like a great chimney. One of the guides at that point venturing a little too near slipped on the steep slope leading to the orifice and was almost thrown in, but happily he checked himself just in time and we were saved from a horrible tragedy.

It was noon, and the openings, which up to that time had been giving off very little vapor — so that no steam could be seen from St. Pierre — began to puff and give off an odor of sulphuretted hydrogen more strongly than heretofore, and at the same time detonations could be heard. We thought of returning, but we wished to visit a third crater seen fuming some hundreds of meters lower down the same ravine, which was said to be the seat of the ancient Soufrière.

Two routes appeared practicable: the one following down the steep crest that we had come up by, in order to find, a little lower down, a less steep slope; the other going directly from the upper orifices to the one below following the same ravine longitudinally; the first of these routes was, according to the guides, the only practicable one; the other passing escarpments and cliffs led to an inaccessible point above the vent. Mr. LePrieur and I followed the guides, Mr. Peyraud and some others who were with us wished to try the more difficult route, but after much trouble, they were obliged to retrace their steps and rejoin us. They had been cut off by those precipices which on the mountain are invisible a very short distance away, but which prove when one reaches them that the straight line is not always the shortest road between two points.

After going down a half hour we arrived at the level of the third crater, but it then became necessary to drop down into the ravine for a depth of fifty feet by sliding on a slope inclined about thirty degrees. Finally we reached the bottom and found the bed of the ravine four or five meters wide, in the middle of which a swift brook runs through a bed of grayish mud. This mud has a thickness of half a meter. On the two banks rise wall cliffs eight to ten meters high. The bottom of this gorge is thus in a fashion shut in. To the east, above, in the direction of the higher vents that we had just left, the ravine is

shut off by a rock wall at the summit of which gushes out the steam of the third crater ; along with the steam, a cascade of water escapes, which falls into the ravine and forms the brook mentioned. Unfortunately it was not possible to climb to the edge of this hole and get a good view of its dimensions. The cliff which rises above it at the back is hollowed out in a sort of cavern, and before it the crater forms a *v* shaped breach whence comes the water of the cascade ; it is probable that the arrangement of these places changes from time to time under the different forces at work, for Mr. Peyraud who had been here in 1838, found the place unrecognizable in 1851. Besides the crater of to-day which was quite new to him, there was lacking a cold spring which our companion had promised us and which for several hours we had counted on for quenching our thirst. We found only springs of hot water, the coolest of them at 37° .

On the heights above the ravine, the Abbé Lespinasse, during the first days of the eruption, had planted a cross, in order to reassure the frightened populace. This is the only barrier that man dares oppose to threatening nature at such a time. The presence of hot water here appeared to us an important basis of more extensive study. On our right looking to the east, about a meter and a half from the bottom of the ravine and three meters from the rock wall which cuts it off, there is a hot spring having a temperature of 70° ; its taste and its odor indicate the presence of sulphuretted hydrogen. The principal jet is about an inch in diameter and all about it are tiny rills at the same temperature : two meters above this first spring and a little further along there is a second spring of the same quality with a temperature of 46° , which falls, by several little cascades, on the rock, from which it rebounds below. The action of the air liberates a great part of the sulphur contained and this is deposited in a light powder on the lower rock, which is coated yellowish white, but in falling lower down on another ferruginous rock it is again decomposed and the sulphur this time combines with the iron to form a black sulphide of iron.

On the same side going higher another spring is found with a temperature of only 22° ; this has a still more sulphurous taste. On the opposite bank two meters from the bottom and one

meter from the end cliff there is another sulphurous spring with a temperature of 90° . The muddy water coming down the brook has very variable temperature; during our exploration, Aug. 29, it was 37° , but on the 30th it was 65° (for the study of the springs about this third crater was found so interesting that Messrs. LePrieur and Peyraud returned twice to take the temperature and to get some bottles of water for analysis). It is to these gentlemen that we are indebted for detailed information concerning the springs; they determined that the temperature of the different springs coming out of the rock was always the same, while that of the main brook varied; this difference according to them is due to the fact that the materials thrown out of the crater mix with the water of the brook, the source of which is rainfall. This is properly the head-waters of the Rivière Claire. According as the ejectamenta are more or less abundant the water is more or less hot. This we had opportunity to prove Aug. 29th, for while we were in the ravine making observations, suddenly several detonations were heard and at the same time blacker and more abundant fumes came from the crater; the water of the brook changed quickly in temperature rising from 27° to 47° . There were twenty of us crowded together in the ravine. Nearly every one was afraid and each sought safety on the adjacent cliff a few meters high. But as this could be reached only by one very narrow path, in single file, the crowding added to our panic. To the credit of Messrs. LePrieur and Peyraud be it said they did not share our fright and remained behind facing the eruption and continuing their observations, and they did not rejoin us until a long time afterwards. At the moment of the noise and the ejection of vapor a cloud of grayish mud was thrown into the air which fell in a very fine powder on our hats and clothing. The brook increased in volume to a blackish gray boiling mass. It did not appear to ever reach a depth of more than one meter, for the mud-stains on the wall were not visible at any point above this height. After three successive explosions the crater became quiet and the vapor became whiter. It was at this time again determined that the noise took place entirely at the orifice of the vent by the expansion of steam in air, and was in no sense

subterranean, for the puff of vapor and the noise were exactly simultaneous. We saw no ejections of fire, stones, or even sand; the only accident that was somewhat remarkable was the detachment of a block of ferruginous rock from the right side of the ravine, which rolled into the depths and broke into pieces. This rock measured twelve to fifteen cubic meters. On the sixth of September, Messrs. LePrieur and Peyraud on their second return hither determined that in spite of the thick masses of vapor thrown out since the 29th of August, and in spite of rain which had fallen twice on the mountain, the level of the brook had not risen. They said that our foot-prints of the last excursion were still visible in the mud of the bottom of the ravine, some of them containing a little water, evidently from rain-fall: in the interval between the two visits there was no change, and the different springs showed the same temperature; in the spring at 70° one could boil eggs, and some of the native crawfish were found cooked.

A copper bucket was thrown into the crater securely attached to a cord; three times the vessel was thrown against the rock wall and was recovered dented, but it was not possible to obtain the slightest particle of liquid; the material of the interior was found to be reddish pumice which accounted for a reddish color that had been at one time observed in the vapor coming from this orifice. While we were there, however, this steam and that from the upper crater always appeared to us white or blackish, the last condition being due to particles of sulphurous mud.

In order to complete the exploration of the scene of eruption it remained to examine the valley where the first openings were made. For the openings that we have just described are not those which opened first. Those which are in action today opened on Saturday, the 9th of August, after a series of detonations more violent than those of the 5th. The first openings are situated in a lateral valley which joins the one where the active craters are, but much lower down. They are today entirely quiescent. From the calm which reigns in their vicinity one would never suppose that a month ago they had served to give vent to the first manifestations of a volcano. These openings are ten in number, along a single line, and trend in the

same direction as the upper vents; behind them is a high cliff which forms the right side of the ravine they occupy. The first is at the same time the lowest and smallest; its diameter is 0.60 meter to 0.70, and its depth about 0.30 m. The bottom is covered with a reddish ferruginous sand and the rocks thereabouts are brownish and tumbled in disorder, doubtless the product of the eruption. The ravine has been deeply excavated by water which has removed the greater part of the soil and left only denuded rocks. The different openings are on a rather steep slope. The tenth which is the highest of all is also the widest and deepest; it is four meters long and a meter and a half wide. Above there is a tree supported by its denuded roots; this vent is quite deep and appears to contain water still, but a line forty feet long failed to reach the bottom; the third opening, counting from below, is also of elongate shape; it is not remarkable except that it is half covered by a boulder which has not been displaced. There are also some plants which have not been totally destroyed and their roots hang denuded in the opening. The bottom of this cavity is, like that of the other, covered by sediment colored with iron oxides. An elevation taken at half past three in the afternoon in the middle of these small openings gave 816 meters above the sea. The thermometer gave 20.5° in the air and 23.5° in the soil; much rain fell on that day.

In returning to the habitation Ruffin and passing the Morne Plumet, — the most elevated point of this part of the mountain and hence named Gros Morne, — one does not encounter any trees, the only vegetation being shrubs, grasses and sedges; at this height (812 meters above the sea) there is a fine view; directly opposite is the ravine of the Claire within which are the three active openings, to the left extends all the district of Prêcheur with its picturesque farm houses situated each on its little hill, and to the right in the distance may be seen the wide landscape of St. Pierre, the city itself with its reddish roofs, and the vessels anchored in the roadstead.

The general direction of trend of the ravine where the active steaming vents are situated is ENE.¹ From the summit of the

¹ The French notation used is N. E. $1/4$ SE. — W. $1/4$ W. (ne $1/4$ s, e-o $1/4$ o).

Morne Plumet the orifice nearest to St. Pierre (that from which the thickest fumes come) is to the east 30° north; the second is 32° north and the third which opens in the ravine is to the east 36° north. St. Pierre lies to the south 10° east¹ at a distance of about 10 kilometers as a bird flies; the town of Prêcheur is about 7 kilometers directly west. The Ruffin house, which is the nearest dwelling, is about 3 kilometers from the upper opening, and 2 kilometers from that situated above La Soufrière; the sugar factory Canonville is 5 kilometers away. From the Grande Rue du Mouillage the upper opening is north 4° east;² it is this which is best seen from below and from this escaped the densest vapors; these entirely mask the second opening which in this direction is behind the first; as to the vapors thrown out by the opening situated in the ancient Soufrière, they cannot be seen from St. Pierre; the high crest which separates Rivière Blanche from Rivière Claire hides this opening entirely.

The 29th of August we returned at two o'clock to the Ruffin House. Our excursion had occupied about seven hours; at the cost of some fatigue we bore with us the memory of one of the most imposing spectacles man had ever seen. But our task was not finished. We had to assure ourselves that there were no other points in the mountain where changes had taken place in consequence of the eruption of the fifth of August. Of course it was important to determine what had happened to the hot waters which exist in the part of Mt. Pelée called Montagne d'Irlande where Mr. A. Desnoux de Messirny has built a bath establishment. Sept. 2, Messrs. Le Prieur and Peyraud betook themselves to that locality and found the water of the spring itself at $35^{\circ}.8$, and at the first faucet of the first bath of the establishment (which is ten minutes walk distant) we found the temperature to be 33° . The weather was clear; — after heavy rains have fallen on the pipes, the loss of heat between the spring and the baths is still greater. Dr. Dutroileau who was at the establishment on account of his health on the night of the fifth of August assured us that no change happened to the water

¹ "Du compas" — presumably *magnetic*.

² "N $1/4$ E."

either in temperature, volume or limpidity. The air here as in all the Prêcheur district is strongly impregnated with the odor of sulphuretted hydrogen and all silver pieces turned brown as well as those paintings which contained compounds of lead. In the night of 5th to 6th of August and the 9th of the same month strong but short shocks of earthquake were felt ; since that time the earth has remained at rest, but from time to time strong detonations may be heard, similar to cannon shots in the distance. At the same time it is stated that a movement is felt such as might be produced by a powerful blow struck beneath the soil. This sensation was also perceived at the Ruffin House but at my residence Fond Canonville, which is not on the massive rock of the hills but on the seacoast, I perceived nothing of the sort.

All along the road leading to the baths and at the spring Messrs. Le Prieur and Peyraud perceived no landslips, even though the walls of the ravine by this road are formed of tufa 20 to 25 meters in height, frequently deeply trenched. This soil is composed of pumice in masses or fragments on which the water has deposited in certain places incrustations. Above the bathing establishment toward the Carbonal House many rocks are found high up the slope which are friable and fine grained, horizontally bedded, and resting on the fragmentary pumice ; these rocks are variously colored and serve as support to the pumice ; this suggests that often eruptions had taken place, throwing out pumiceous rocks and that in the intervals the flowing water in its turn had deposited the particles held in suspension during the calm periods. Along the lower part of the road all these beds are very well shown, especially in those portions artificially trenched ; there are there several good sized heaps of ancient volcanic cinders of a faint violet tint and rather more sandy in quality than the muds thrown out today ; there are no metallic particles ; some are reddish like the sands found near the little extinct vents, or on the steep slope back of the vent called La Soufrière.

There remained another important point to determine : namely, what had happened to the actual summit of the Montagne Pelée, where there is a lake supposed to be the seat of an

ancient crater. Seen from St. Pierre the mountain did not appear to have changed at all in height, but had nothing happened to the waters of the lake? No one knew, for no one had been there since the eruption of August 5th, and on this account Messrs. Le Prieur and Peyraud resolved to explore the summit on 4th Sept. The trail to the summit of Mt. Pelée is more travelled than that which leads to the craters. The inhabitants of St. Pierre sometimes make picnic excursions to the summit. Leaving the Eynard House near the base of the mountain, the spur is followed which leads beside and overhangs the ravine of the Rivière Sèche. For three quarters of an hour one passes cultivated lands, the earth there being loose and formed of fragmentary pumice covered by a thin bed of vegetable mold which is very permeable; vegetables are raised on these slopes. Then the traveller comes to the great woods, fig trees covered by vegetable parasites, and long lianas which climb to the very summits of these forest giants and then swing back to earth where they throw out roots and form a dense mass of vegetation entirely distinctive of the tropics. On leaving these woods at the end of an hour, the trees are seen to grow smaller and are gradually replaced by low shrubby and herbaceous vegetation; but none the less the botanist finds here too a constant source of delight. I saw, wrote Mr. Le Prieur, superb flowers worthy of hot-houses, especially two superb cromelias, the one with a long spike of flowers, the other with yellow and red flowers; there are the Brazilian huckleberries, with violet-red flowers; three beautiful species of lobelia, with great flowers which recall some of the fields of certain portions of France. This last plant is found about the lake, and on the humid slopes leading to Morne LaCroix, the culminating point of the mountain—so named because a cross has been placed there. In general, of all the floras of the Antilles, that of Martinique is least known because of the trigonocephalus, whose terrible reputation frightens away the hardest botanist. Our explorers started at seven o'clock and reached the lake at half past ten. According to the guides who are accustomed to the place no change has taken place in the lake. It is some three hundred paces in circumference; the thermometer gave a temperature in air of 19° and in

the water $20^{\circ}.5$. Nevertheless, the temperature seemed much colder on account of a north wind blowing strongly at the time, and the dense fog over the mountain. This prevented them from viewing the magnificent spectacle ordinarily seen when the weather was fair—a view inclusive from the Grenadines to Antigua. The water of the lake was as abundant and as clear as usual. A maceration within it of certain vegetable matter gives it a grassy taste. Before arriving at the lake it was necessary to cross a crevasse 40 m. wide, which crosses the whole width of the spur that they followed, and is well known to those who have taken this excursion. This crevasse has not been changed at all nor widened. Neither on the road nor from any point of view was any trace of disturbance seen.

The bottom of the lake is carpeted with a layer of thin mud and this rests upon a heap of fragments of pumice of yellowish gray color partly decomposed and recemented by a little ferruginous clay. On the southwest border of the lake a small beach has formed, composed of very fine grains from the debris of these pumiceous rocks which the movement of the waves, raised by the north wind, bring there continually, for there is not on that side any elevation to protect the rocks from the action of the wind. At the summit of Morne LaCroix the barometer gave an elevation of 1277 meters above the level of the sea. This is the highest point of the island. The thermometer in air gave $18^{\circ}.5$ and in earth $19^{\circ}.2$. From this point steam could be seen toward the west, coming out of the upper craters 400 meters lower down. A little more to the left not quite so far down there was seen from time to time a water surface showing bluish reflection, filling the basin called formerly by the guides the “dry pond” (étang sec), because ordinarily this basin is empty.

Even on the plants of the summit of Morne La Croix, traces of volcanic cinders were found which had been carried to this point. Messrs. Le Prieur and Peyraud, not being willing to leave the mountain without a visit to the dry pond—which is commonly believed to be another more ancient crater of the volcano—visited it during their descent by means of a trail rarely used, very difficult and seldom visited before they went

there. They found this supposed "dry" pond filled by a considerable mass of water and according to their estimate five times greater than the upper lake: the guides attributed the presence of this water to the abundant rains which had truly been extraordinary during the "hivernage" of 1851; they asserted that during the previous lenten season this pond had been dry.¹

The barometer here gave an altitude of 921 meters above the level of the sea. Thus this dry pond is at almost the same elevation as the upper vents of the volcano which are in a ravine beyond. Nothing else was found changed in these localities according to the guides, and nothing in the way of fissures nor disturbances. After this last expedition our official work was finished; we had learned that the action of the volcano did not extend beyond the limits we had explored, and that it was confined to the ravine where the Rivière Claire takes its rise and that immediate vicinity. It was useless to examine the northern slope of mountain toward Macouba, for the inhabitants of that quarter observed nothing extraordinary except an odor of sulphuretted hydrogen, which, it is said, was perceived even as far as St. Marie. At Macouba the leaves of the trees were coated with only the barest trace of those cinders which caused such a fright in St. Pierre.

¹ Some naturalists think that the heat of certain volcanoes comes from no great depth and the water which they throw out is merely rain water which penetrates by means of the fissures in the earth and accumulates in subterranean cavities; several of the observations made during our eruption of the fifth of August lend support to this opinion: (1) the years 1850-1851 had been very rainy, so much so that the dry pond of the mountain has been found full of water and this has become for us a sort of pluviometer; (2) the shocks of earthquake and sensation of bumping under the soil were felt only on the slopes of the mountain, in those little estates situated probably above the level of the seat of volcanic activity—in those which are below this level on the flat land or on the seashore (as at my house in Fond Canonville) although they are still sufficiently near the volcano, nothing of the sort was felt. Moreover at Fond Canonville the springs which escape from the foot of the surrounding hills, like the Fontaine Chaude, have not been in any way changed. It seems to me there is great probability that the volcanic furnace is in the body of the mountain and not at its roots.

Conclusions.

Doubtless no dissertation will be expected from us on the cause and nature of the Mt. Pelée volcano. This study would require a professional knowledge other than we possess; we have merely tried to fulfill the request of the government and report upon the extent of the accidents occasioned by the eruption of the 5th of August and certain exact details. We will vouch for nothing beyond the facts which we ourselves have determined. If these facts, compared with those possessed by science already à propos of the other volcanoes of the earth (more than two hundred in number) can throw some light on the nature of this great phenomenon we shall be well satisfied. But it is not our task to enter upon such matters. The following we can vouch for:—

The eruption of the fifth of August was entirely a local event bounded by the ravine of the Rivière Claire, devastating an area 800 to 900 meters broad at the outside.

The effects of the eruption were at first a continuous buzzing sound, then a series of intermittent detonations, and simultaneously there was thrown out a jet of white or black vapors which made a deposit wherever they spread in the shape of a grayish mud or cinder; and these vapors produce in their vicinity a strong odor of sulphuretted hydrogen.

It is not possible to assert whether this material is always thrown out in the form of cinders or powder, or not sometimes in the form of a rain of mud. It is more probably in a powdery condition and when it falls on the trees it is moistened by steam, or when it falls on the ground it becomes mixed with rain water and forms a sort of clay.

The eruption of the fifth of August was not accompanied by any noticeable earthquake in Martinique, even in the Prêcheur district. Since that time no shocks have been felt. In this respect the opening of these vents seems to be for our island a happy event, a kind of safety valve giving vent to subterranean gases and vapors and so protecting us from those earth commotions which formerly produced such desolation here. "It happens," says Buffon, "that in the lands subject to earthquake,

when a new volcano breaks out earthquakes cease and are only felt during the violent eruptions of the volcano; this has been observed on the island of St. Christopher; and the great encyclopædia begins its article on "volcanoes" as follows: "Volcanoes are a beneficent device of nature, etc. etc."

The buzzing sounds of detonations are not produced by subterranean ebullition, but they take place simultaneously with the ejection of vapor and are produced at the orifice of the vent.

The cinders or muds are the only materials thrown out by the volcano. We have found neither lavas, nor even stones of the smallest possible dimensions which could be identified as eruption products.

The geological structure of Mt. Pelée, as far as our incomplete observations go, shows no lava flows: "for we must not include under the name of lavas," says a geologist, "all the materials ejected from the throat of a volcano such as cinders, pumice stones, gravels, sand; but only those which, reduced by the action of heat to a liquid condition, form on cooling solid masses the hardness of which is greater than marble." These lavas exist principally in the vicinity of volcanoes which eject fire. Now we find about our volcano only pumice, generally fragmentary, and some deposits of cindery substance, in the middle of which appear diorite fragments, torn out of the interior of the earth in preceding eruptions.

This geological structure of Mt. Pelée leads to the belief that the earlier eruptions (which show at least two craters, the dry pond and the lake above) have been of the same nature as that of the fifth of August. Everything goes to show that this volcano should be ranked with the cinder, or mud volcanoes, and not with fire volcanoes (*volcans de feu*).

Compared with the common notion of the Soufrière of Guadeloupe, what we have learned concerning the new vents of Mt. Pelée is closely similar. It is probable that the conditions are about the same in the case of the Soufrières of St. Lucia, Dominica and Montserrat.

As to Guadeloupe, there have been eruptions several times, notably in February 1837, and December 1846.

These eruptions have always opened new fumaroles and ejected cinders and thick mud.

Mt. Pelée when closely examined shows no fissures, landslips, nor displacement of waters, and hence the action of the eruption of the fifth of August was very local.

The city of St. Pierre situated more than ten kilometers away, and the town of Prêcheur distant seven kilometers, appear to be out of danger from eruptions even considerably greater than the one which has taken place. Nothing in the land where they are situated indicates great catastrophes. Even to reach the Ruffin House or the Eynard House, which are nearest to the vents, a disturbance would be necessary very different from the present one. The matter thrown out even in the immediate vicinity of the vents did not reach a depth of more than a meter. This material finds a natural path of flow in consequence of the steep slope and the gorge of the Rivière Blanche whose waters naturally carry it off to the sea. Further the planters who fled at first have since returned to their dwellings, and their work, and have no further fear of the noises heard from time to time nor of the odor of sulphuretted hydrogen that is continually perceptible.

This odor impregnates the atmosphere all about Mt. Pelée and extends even beyond. It augments or diminishes in certain places according to the direction of the wind; it is sometimes comparable to the odor of burnt gunpowder, at other times to that of stirred up swamp mud; up to this time this odor appears to be merely disagreeable and has had no unsanitary effect either upon men or animals. However, for some time I have been struck with the large number of persons of the Prêcheur district, especially on the habitation Beligny and in my own plantation, who have consulted me about skin troubles and insomnia which they attribute to the sulphurous emanations. I have seen cows drinking the muddy water of the Rivière Blanche and the proprietor assures me that they suffered no ill effects. I have not observed any flight of the birds away from the district though one would suppose their respiratory systems must be very sensitive. Silver pieces in all the estates of the Prêcheur quarter turn brown, and so do all paintings which contain compounds of copper or lead. It is worthy of note that at Guadeloupe the exhalations of sulphuretted hydrogen are not perceived in the

vicinity of the Soufrière — hence we may hope that here also they may cease in due time. No great deposits of pure sulphur have been found either here or in Guadeloupe. Everywhere the sulphur appears to be in a state of combination.

Moreover it should be observed that the presence of sulphuretted hydrogen in the atmosphere in all those localities where there are thermal sulphur waters is not regarded as unhealthy; the waters of Vernet and of Cauterets give out these exhalations and they are believed salutary for people with pulmonary trouble, therefore we may hope that the Prêcheur district, already renowned for its therapeutic qualities in the treatment of these diseases, may acquire a new title to fame in the eyes of such invalids.

But the most remarkable result of our excursions and the most interesting is the information about the place formerly called La Soufrière. There in a very small area four springs of different temperature occur close together, of which three are sulphurous at temperatures of 90° , 70° , and 46° . The other is cold with a temperature of 22.5° and while not being very good to drink is not the less potable. The hot springs contain free sulphuric acid (*acide sulphydrique*) which volatilizes in consequence of the heat and leaves a residue on evaporation weighing two drachms for each meter of water; this residue of soluble salts contains sulphuric acid and hydrochloric acid combined with soda, potash, magnesia, lime and iron as well as a small quantity of silica.

It is to be hoped that at some time when calm shall have been re-established at the seat of eruption, and in the minds of the inhabitants, that some bold speculator will turn to our advantage that which has given us such a fright and will build an establishment of thermal waters in the midst of these places now so desolate. These waters could be conducted to a reservoir so disposed, that their high temperature might be reduced without the loss of their beneficial properties.

Summing up the volcano La Montagne Pelée, it appears to be merely one more interesting curiosity added to the natural history of Martinique — a curiosity that foreigners will wish to visit and which with fitting industry on the part of the natives may

be made a source of health and wealth — in calm weather the ships coming from France will see from a distance the long billow of white vapor rising straight toward the heavens, and will find this a picturesque addition to the landscape — the last touch needed to complete the majesty of our ancient Montagne Pelée.